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(56) Documents Cited
GB 2289752 A
EP 0505116 A2
DE 004306215 A
DE 003148573 A

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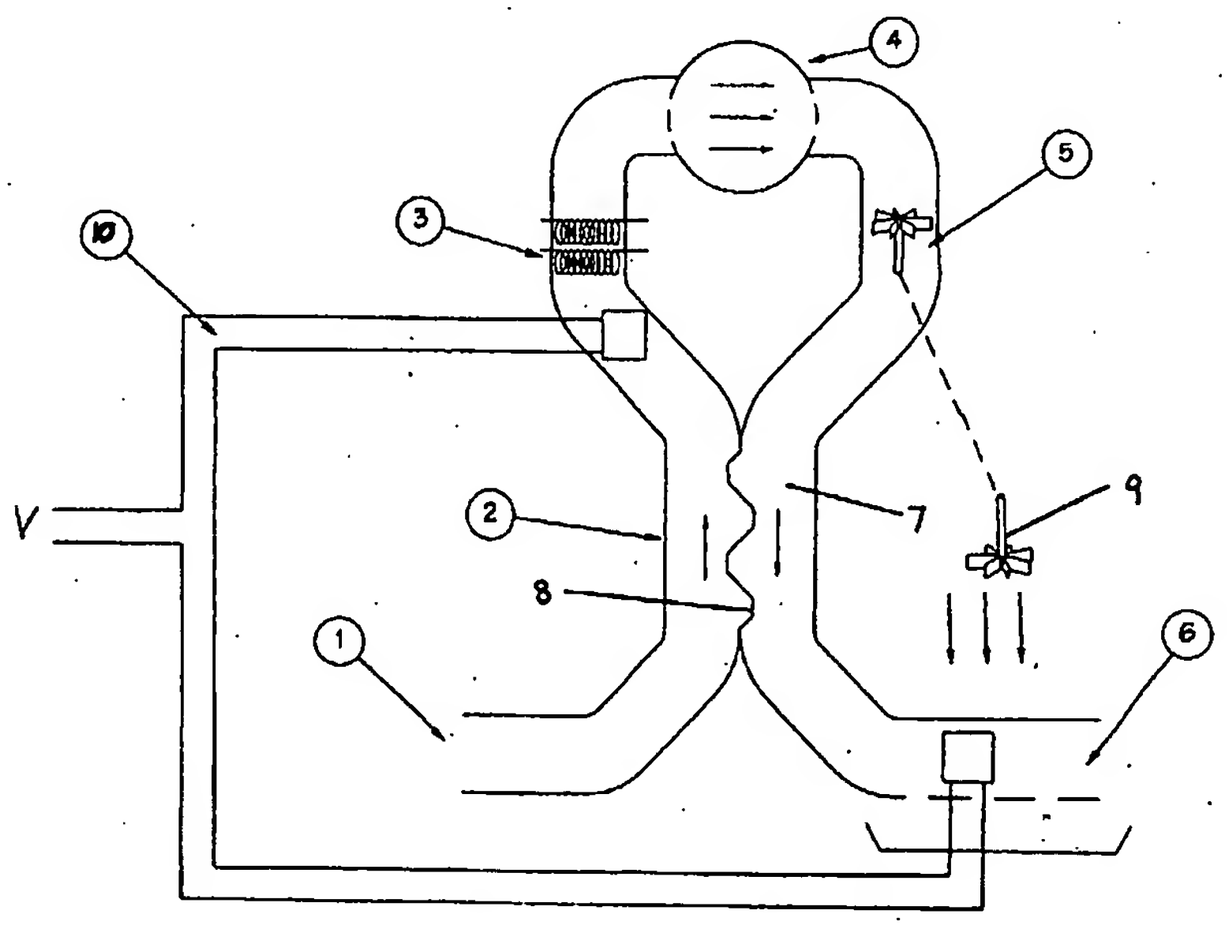
ONLINE: EPODOC, WPI & JAPIO

(54) Abstract Title
Drying apparatus with heat exchanger and heat pump

(57) Air being fed to a drying chamber 4 is pre-heated by the air leaving the chamber 4 in a heat exchanger 2 formed by an inlet duct 2 being adjacent to an outlet duct 7. Where they are adjacent the walls of the inlet duct 2 and the outlet duct 7 may have corrugations 8. The dryer, which may be a laundry tumble dryer, also comprises an impellor 5 and a heater 3. A heat pump 10 with it's condenser in the inlet duct 2 and it's evaporator in the outlet duct 6 may be included to assist the transfer of heat from the outlet air to the inlet air. The structure may be so arranged that the air pressure decreases as it passes through the condenser or increases where an increase in the temperature is required.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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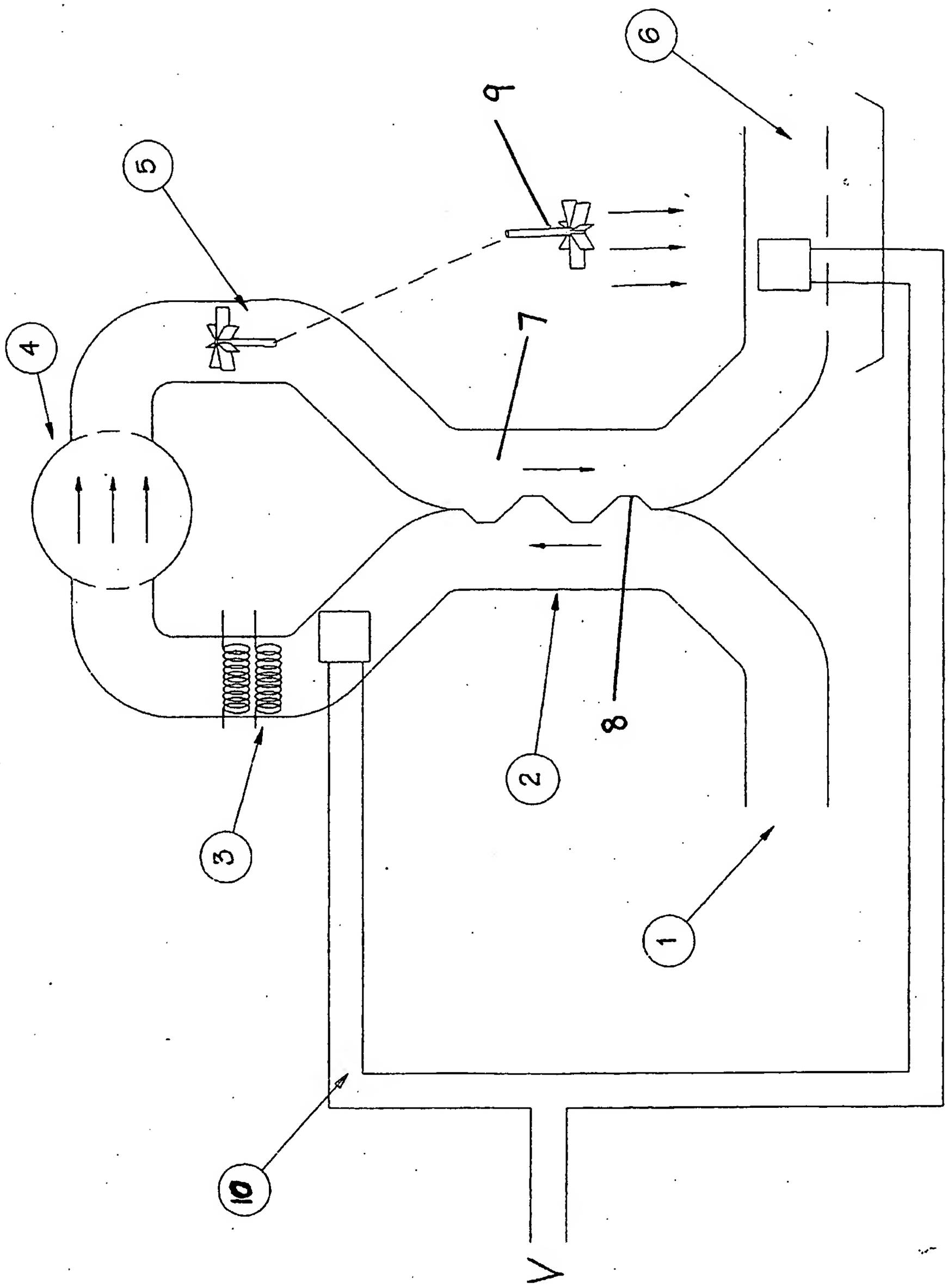
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IMPROVEMENTS RELATING TO DRIER DEVICES

In the simplest arrangement of air drier, air is drawn through a drum containing the material to be dried. Inlet air is heated, and absorbs water from the material. The exhaust air is vented to ambient air. There is a significant energy loss in the heated moist air vented to atmosphere. It is an object of this invention to limit heat losses in such a structure.

According to the invention there is provided a drier device incorporating a drier drum or other container having an air inlet passageway incorporating a heater and an outlet passageway, and an air impeller for causing air to pass through the container from the inlet passageway to the outlet passageway, parts of the two passageways being located adjacent to each other to create a heat exchanger at a position upstream of the heater within the inlet passageway.

In standard air heaters for applications such as tumble-driers, the exhaust air is hotter than the surroundings, and the heat is wasted. By using a heat exchanger to transfer heat from the exhaust air to the inlet air before the heating element, the thermal efficiency of the drier is increased, since a lower temperature rise is required from the heater. If the inlet air is raised in temperature by 30°C, then input power of only 70% may be required compared to the unit without a heat exchanger.

Ideally the adjacent parts of the two passageways will define matching convoluted wall surfaces.

The efficiency may be increased further by incorporating a heat pump to transfer heat from the outlet passageway downstream of the heat exchanger to the inlet passageway upstream of the heater. The heat pump may be of an electrical type (e.g. a Peltier device) or a mechanical (evaporation/condensation cycle) type. Preferably the outlet passageway will incorporate a condenser drier downstream of the heat exchanger, with the heat pump being connected from the condenser drier. Ideally in such an arrangement the structure causes a decrease of pressure of air passing through the condenser. In a condenser drier the exhaust air is passed through a condenser where the air temperature is reduced to near ambient. A second air blower is normally used to provide sufficient heat transfer. The increase in relative humidity due to the temperature reduction causes the removed moisture to condense out. The exhaust air may then be vented into the area where the drier is operating. Usually it is ducted to re-enter the drier circulation. However its relative humidity cannot be reduced below 100% at ambient temperature, and this causes the air passing through the drier to be at a higher humidity compared to ambient air, reducing the effectiveness of the drying process. However, with a condensing type drier, where the outlet air is cooled to remove the water vapour from the exhaust air

before venting to the surroundings, the heat pump enables the removal of a higher proportion of the evaporated moisture. Since the air is cooled before the condenser, a smaller condenser unit is required, with attendant material and space savings.

The air impeller may be positioned before the drier drum ('forced air') or after it ('drawn air'). Typically, the air temperature is raised by 100°C, and the temperature drops by 40°C across the drier, giving a maximum efficiency of 40% and actual efficiency closer to 25% due to other heat losses in the system.

The vented air contains the removed moisture, and is therefore at high humidity. It must be vented to an area where condensation is not important, and where it will not re-enter the drier circulation, otherwise some of the input heater power will be used to re-evaporate the removed moisture, further reducing the efficiency.

The addition of a heat pump to transfer heat from the condenser to heat the inlet air before the heat-exchanger has two beneficial effects. Firstly, there is a further increase in efficiency, since the heat energy previously lost in the condenser is now transferred to the inlet air. If the air temperature is increased by 20°C (with a corresponding reduction in exhaust temperature of 20°C), then the input power required may be only 50% of the original power. Secondly, the condenser may reduce the outlet air temperature below ambient, reducing the absolute

humidity of the air, so that external condensation is reduced, and exhaust air re-entering the drier circulation system will have little or no effect on the drier efficiency.

Further improvements in efficiency may be made by constructing the air guides and positioning the air impeller so that the pressure increases where a temperature rise is required (e.g. before entering the drying chamber) and pressure decreases where cooling is required (e.g. in the condenser) to take advantage of adiabatic effects.

The invention may be performed in various ways and the preferred embodiment of a drier device of this invention will now be described with reference to the accompanying drawing.

The device shown in the drawings comprises essentially a domestic tumble drier having a drier drum 4 fed by an air inlet 1 which incorporates a heater 3. The heated air entering the drum 4 helps to dry the clothes and the moisture-laden air then passes out through an air outlet 7, under the influence of an air impeller 5. The inlet and outlet passageways are brought together at a heat exchange portion 2 having a common convoluted adjoining wall 8. Thus some of the heat in the expelled air in the outlet passageway 7 is transferred to the incoming air in the inlet passageway 1. Towards the end of the passageway 7 there is provided a condenser unit 6 (provided with a further impeller 9). Within the condenser unit 6 there is

provided a heat pump 10 which extracts further heat from the exhaust air and transmits the extracted heat to the inlet passageway 1 upstream of the heater 3.

CLAIMS

1. A drier device incorporating a drier drum or other container having an air inlet passageway incorporating a heater and an outlet passageway, and an air impeller for causing air to pass through the container from the inlet passageway to the outlet passageway, parts of the two passageways being located adjacent to each other to create a heat exchanger at a position upstream of the heater within the inlet passageway.

2. A drier device according to Claim 1, wherein the adjacent parts of the two passageways define matching convoluted wall surfaces.

3. A drier device according to Claim 1 or Claim 2, wherein a heat pump is incorporated to transfer heat from the outlet passageway downstream of the heat exchanger to the inlet passageway upstream of the heater.

4. A drier device according to Claim 3, wherein the outlet passageway incorporates a condenser drier downstream of the heat exchanger and the heat pump is connected from the condenser drier.

5. A drier device according to Claim 4, wherein the structure causes a decrease of pressure of air passing through the condenser.

6. A drier device according to any one of Claims 1 to 5, wherein the structure causes an increase in pressure of air entering the chamber or another point where a temperature rise is required.

7. A drier device substantially as herein described with reference to the accompanying drawings.

INVESTOR IN PEOPLE

Application No: GB 0207910.1 **Examiner:** Robert Barrell
Claims searched: 1 - 7 **Date of search:** 20 September 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): F4G (GCRA), (GCCN) & (GCRB)

Int Cl (Ed.7): F26B 11/02; D06F 58/00, 58/02, 58/10, 58/24, & 58/26.

Other: ONLINE: EPODOC, WPI & JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2289752 A	(ACMA THERMAL RESEARCH) See: fig 1 - heater 28, blowers 30 & 32, heat exchanger 26; fig 3- air in 40, air out 46, cabinet 12, and; page 5 - lines 11 - 21 inlet/outlet passages form heat exchanger.	1, 2 & 6
X	EP 0505116 A2	(URCH) See: fig 2 - chamber 12, air inlet 28 & outlet 29, air entering chamber via grill 14 and leaving via grills 16 & 19; figs 3 & 4 - blower 21, blower 41,42, heater 22, heat exchanger 25, inlet air 45, outlet air 30, and; column 5, line 57 - column 6, line 56 - describing drying..	1 & 2
X	DE 3148573 A	(WULFF ALBRECHT) See: WPI abstract; page 10 line 19 - page 12, line 3 - operation description, and; fig 1 - drum 22, heater 21 blower 19, heat exchanger 30, air inlet 15, air outlet 16.	1, 2 & 6
A	DE 4306215 A1	(LICENTIA) See: WPI abstract and fig 1- closed circuit drier with heat pump and heat exchanger.	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.